4.12 Geology/Soils

Information contained in this section is summarized from the *Geologic Hazards Evaluation* prepared by Kleinfelder, Inc. (August 16, 2006). This document is provided in Technical Appendices - Volume II of II, Appendix J, of this EIR.

4.12.1 Existing Conditions

4.12.1.1 Geology

The project site is located within the central, southern portion of the Colorado Desert geomorphic province of California (Kleinfelder, 2006). This province consists of a low-lying fault bounded tectonic graben that stretches south from the southeastern boundary of the Transverse ranges approximately 100 miles to beyond the Mexican border. The central part of the graben basin, which encompasses the project site, is underlain by a thick deposit of Pliocene to Pleistocene age sediments. Specifically, the soil at the project site is a mixture of silty clay loam and silty clay (HDR, 2006). The silty clay loam and silty clay are identified as the Imperial type.

4.12.1.2 Seismicity

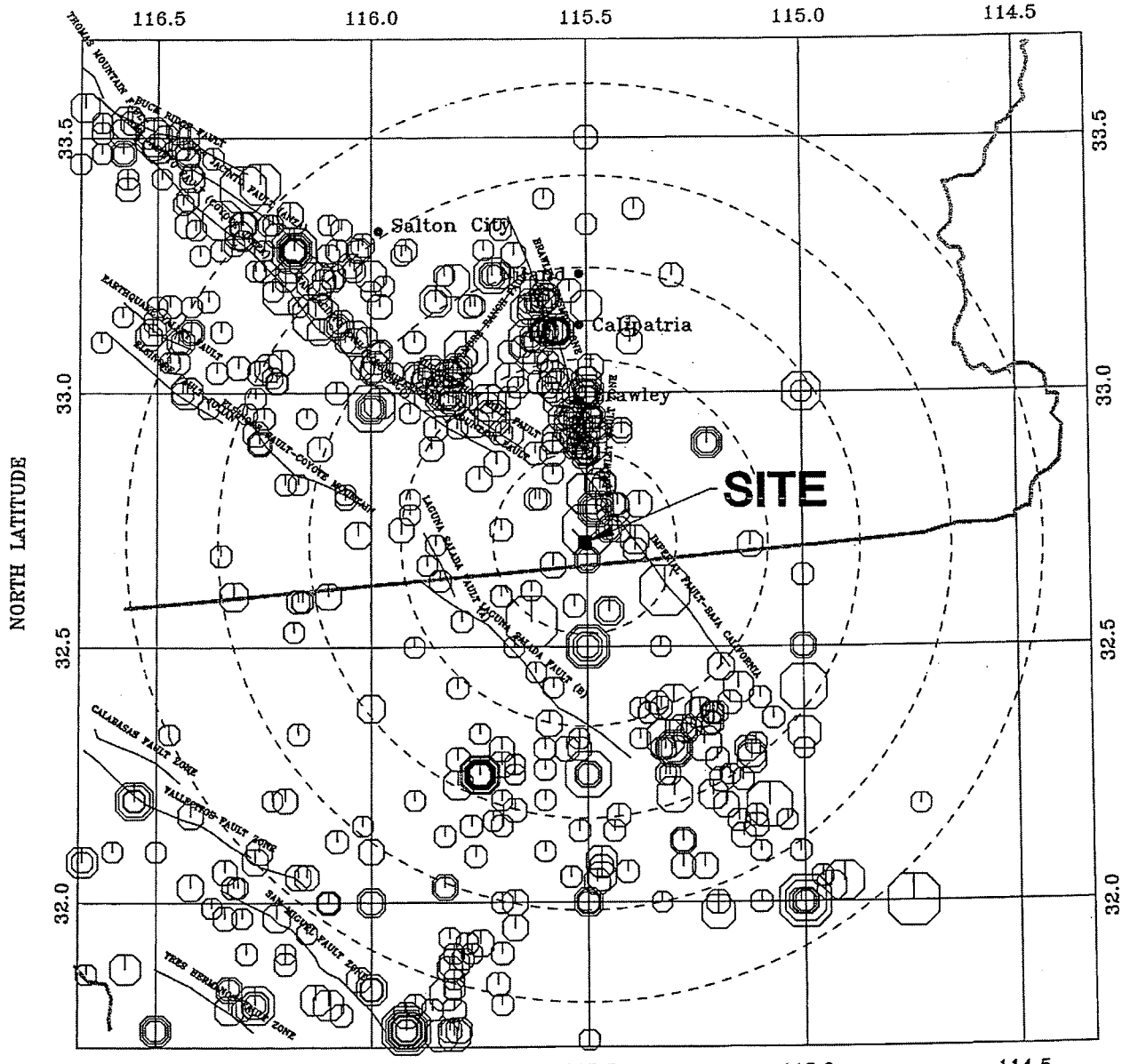
As is common in most of Southern California, the project site is located within a seismically active region. There are a number of faults considered active in Southern California. These include, but are not limited to the Imperial Valley faults and faults in the San Andreas Fault system, the San Jacinto Fault system, and the Elsinore Fault system. No known active fault or potentially active fault is known to exist on, or in the immediate vicinity of the project site. The nearest known active fault is the Imperial fault, located approximately five miles northeast of the project site. Figure 4.12-1 depicts the location of regional active faults. Potential hazards that occur from seismic activities include ground shaking, surface rupture, liquefaction, and landslides.

A. Ground Shaking

The seismic hazard most likely to impact the project site is ground shaking resulting from an earthquake on a major active fault. The Imperial Valley is located in one of the most seismically active regions of the world. The amount of ground shaking that an area may be subject to during an earthquake is related to the proximity of the area to the fault, the depth of focus, location of the epicenter and the size (magnitude) of the earthquake. Soil type also plays a role in the intensity of shaking. Bedrock, or other dense or consolidated materials are less prone to intense ground shaking than soils such as alluvium. Ground motion at the site estimated through the California Geologic Survey website indicate maximum accelerations of approximately 0.53g at a 10% probability of being exceeded in a 50 year period. The proposed improvements should be designed in accordance with the latest (2001) edition of the California Building Code (CBC) for Seismic Zone 4 to mitigate the effects of ground shaking.

B. Fault Rupture

Fault rupture occurs when movement on a fault deep within the earth breaks through to the surface. Rupture almost always follows pre-existing fault strands and may occur suddenly during an earthquake or



PROJECT LOCATION 32.7048N -115.5052W

RADIUS OF LARGEST CIRCLE IS 100 KM

SOURCE: Kleinfelder, 2006

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BRG CONSULTING, INC.

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Fault Map and Epicenters of Earthquakes

FIGURE 4.12-1

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slowly in the form of fault creep. Fault rupture represents a primary or direct potential hazard to structures built on an active fault zone. The project site does not lie within a State of California Alquist-Priolo Earthquake Fault Zone.

C. Liquefaction

Liquefaction of soils can be caused by strong vibratory motion due to earthquakes in soils that have cohesionless characteristics. Liquefaction occurs primarily in saturated, loose, fine- to medium-grained sands, and most commonly occurs in areas where the groundwater table is less than 10 to 30 feet below the ground surface. When these sediments are shaken, a sudden increase in pore water pressure causes the soils to lose strength and behave as a liquid.

Four conditions are generally required for liquefaction to occur: 1) the soil must be saturated (relatively shallow groundwater); 2) the soil must be loosely packed (low to medium relative density); 3) the soil must be relatively cohesionless (not clayey); and, 4) ground shaking of sufficient intensity must occur to function as a trigger mechanism.

Groundwater

Groundwater seeps were not observed at the project site. However, perched groundwater conditions are anticipated due to the historic and present irrigation within the area and the presence of the main canal structures directly adjacent to the south and west property boundaries.

D. Landslides

Landsliding is caused by slopes becoming unstable and collapsing. Landsliding or slope instability may be caused by natural factors such as fractured or weak bedrock, heavy rainfall, erosion, earthquake activity, and fire, as well as by human alteration of topography and water content.

4.12.1.3 Soils

Soil data for the project site was obtained by BRG Consulting, Inc. from the Soil Survey of Imperial County (U.S. Department of Agricultural Soil Conservation Service, 1981). Soils anticipated to be located on the project site are Imperial silty clay, wet or Imperial-Glenbar silty clay loams, wet, 0 to 2 percent slopes. Imperial soil is very deep and is formed in clayey sediment from mixed sources. Glenbar soil is also very deep and is formed in alluvium of mixed origin. Both soils have slow permeability.

A. Expansive Soils

Expansive soils are primarily comprised of clays, which increase in volume when water is absorbed and shrink when dry. Expansive soils are of concern since building foundations may rise during the rainy season and fall during dry periods in response to the clay's action. In general, much of the near surface soils in the Imperial Valley consist of silty clays and clays which are moderate to highly expansive.

B. Collapsible Soils

Collapsible soils are comprised of low-density open soil material with a high void ratio. These soils can support light to moderate building loads often for years with no noticeable adverse settlement. However,

when these soils become saturated under load, the open grain lattice structure fails due to hydro-consolidation resulting in settlement (collapse). Soils prone to collapse typically consist of recently laid alluvial sands and silty sands deposited during flash flood type events in desert environments.

4.12.2 Impact Thresholds

For the purposes of this EIR, a significant impact would occur if the proposed project would:

- *Expose people or structures to potential substantial adverse effects, including the risk of loss, injury, or death involving:*
  - *i. Rupture of a known earthquake fault as delineated on the most recent Alquist-Priolo Earthquake Fault Zone Map;*
  - *ii. Strong seismic ground shaking;*
  - *iii. Seismic-related ground failure, including liquefaction; or*
  - *iv. Landslides;*
- *Result in substantial soil erosion or loss of topsoil;*
- *Be located on a geologic unit or soil that is unstable, or that would become unstable as a result of the project, and potentially result in on- or off-site landslides, lateral spreading, subsidence, liquefaction or collapse;*
- *Be located on expansive soil, as defined in the latest Uniform Building Code, creating substantial risk to life or property; or,*
- *Have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems where sewers are not available for the disposal of wastewater.*

4.12.3 Impact Analysis

4.12.3.1 Geology

Due to the presence of expandable and collapsible soils on the project site, these soils are not considered suitable for foundation and/or fill support unless the materials are removed, moisture conditioned, and placed as properly compacted fill. This is considered a significant impact. Implementation of Mitigation Measure GS1 will reduce the impact of existing unsuitable soil conditions on the project site to a level less than significant. Mitigation Measure GS1 requires that a detailed geotechnical evaluation shall be performed at the project site to evaluate potential liquefaction, expansive soils, and collapsible soils and provide recommendations to mitigate any impacts identified by this evaluation. All recommendations of the detailed geotechnical evaluation shall become mitigation measures and shall be implemented prior to and during the construction of the project.

4.12.3.2 Seismicity

A. Ground Shaking

The project site is located in a seismically active region, and as such is likely to be subject to at least one moderate to major earthquake during the design life of the structures. The potential for ground acceleration, or shaking, on the project site is considered similar to the Southern California region. The nearest known active fault is the Imperial fault, located approximately five miles northeast of the project site. The potential impact related to ground shaking would be addressed through compliance with the latest (2001) edition of the California Building Code (CBC) Standards for Seismic Zone 4. No significant impact is identified for this issue area.

B. Fault Rupture

The project site is located in a seismically active region, and is likely to be subject to at least one moderate to major earthquake during the design life of the structures. The nearest known active fault is the Imperial fault, located approximately five miles northeast of the project site. Surface rupture is not considered a potential impact as no known active or potentially active fault traverses, or is located in the near vicinity of the project site. No significant impact is identified for this issue area.

C. Liquefaction

Liquefaction is a phenomenon whereby a loose (unconsolidated) cohesionless saturated soil looses its shear strength (liquefies) during periods of oscillatory ground motion caused by an event such as seismic shaking induced by an earthquake. Liquefied soils undergo significant loss in support capacity, which can result in catastrophic settlement of structures. Soils prone to liquefaction consist of poorly consolidated sands and sandy silts in area of high groundwater.

Regional geologic interpretations indicate that the soils below the project site contain a large percentage of fine-grained silt and clay material. However, sands and silty sands are known to occur within the lake deposits. Perched ground water is also anticipated at the project site due to the addition of water from agricultural irrigation. Based on these potential site conditions, there is a potential for liquefaction to occur on the project site which is considered a significant impact. However, with the implementation of Mitigation Measure GS1 this impact will be reduced to a level less than significant.

D. Landslides

The hazard of landsliding on the project site is unlikely due to the regional planar topography. No ancient landslides are shown on geologic maps of the region and no indications of landslides were observed during the site investigation. No significant impact to this issue is anticipated.

4.12.3.3 Tsunamis

Tsunamis are large, broad sea waves that result in response to large vertical displacement of ocean bottom faults or movement of submarine landslides. Tsunami hazard due to submarine faulting or landsliding from both near field and far field sources are considered as probable hazards for the California

coast. Based on the great distance of the site from the Pacific Ocean and Gulf of California, the tsunami hazard is low.

4.12.3.4 Flooding

The Federal Emergency and Management Administration (FEMA) maintains a collection of Flood Insurance Rate Maps (FIRM), which cover the entire United States. These maps identify areas that may be subjected to 100-year or 500-year cycle floods. The project site is included on Imperial County FEMA flood map Panel 1025, and is not located on a cycle floodplain.

4.12.3.5 Expansive Soils

The project site is, in general, underlain by fine-grained clays and silts of moderate to high expansion potential. The potential for expansive soils to affect the proposed project is considered a significant impact. Implementation of Mitigation Measure GS1 will reduce the impact of existing unsuitable soil conditions on the project site to a level less than significant. Mitigation Measure GS1 requires that a detailed geotechnical evaluation shall be performed at the project site to evaluate potential expansive soils and provide recommendations to mitigate any impacts identified by this evaluation. All recommendations of the detailed geotechnical evaluation shall become mitigation measures and shall be implemented prior to and during the construction of the project.

4.12.3.6 Collapsible Soils

The soils found at the project site are silty clay loam or silty clay. It is not anticipated that the soils underlying the project site would be subject to collapse, but due to the desert environment it may be possible some layers of collapsible soils may be present at the project site. Implementation of Mitigation Measure GS1 will reduce the potential differential settlement impacts to a level less than significant.

4.12.3.7 Soil Erosion

Grading requirements of the project site have the potential to alter existing drainage patterns, causing erosion or siltation on the site or in the area on a short-term basis during construction. Implementation of Mitigation Measure HWQ1 (see Section 4.8 – *Hydrology and Water Quality* - of this EIR) will reduce the potential soil erosion impact to a level less than significant. Mitigation Measure HWQ1 requires implementation of a Storm Water Pollution Prevention Plan (SWPPP) to incorporate required Best Management Practices (BMPs) on the construction site in order to reduce any impacts related to soil erosion and water quality to a level less than significant. Therefore, with the implementation of mitigation measure HWQ1, the impact related to soil erosion will be reduced to a level less than significant.

4.12.4 Significance of Impacts

Significant hazards at the project site with respects to landsliding, fault rupture, tsunamis, or flooding were not found. Ground shaking from earthquakes on nearby faults is considered a significant hazard at the site. The impact of seismic shaking is a regional hazard that affects the entire Imperial Valley; however, compliance with the CBC Building Standards will reduce this impact to a level less than significant. Potential significant impacts to the project site would be liquefaction, expansive soils and collapsible soils.

4.12.5 Mitigation Measures

GS1 The project shall be designed and constructed in accordance with the most recent standard California Building Code (CBC) and Uniform Building Code (UBC) building conditions.

As part of project structural design and prior to issuance of a grading permit, a detailed geotechnical evaluation shall be performed at the project site to evaluate potential liquefaction, expansive soils, and collapsible soils and provide recommendations to mitigate any impacts identified by this evaluation. All recommendations of the detailed geotechnical evaluation shall become mitigation measures and shall be implemented prior to and during the construction of the project.

HWQ1 Please see Section 4.8 Hydrology and Water Quality of this EIR.

4.12.6 Conclusion

Implementation of Mitigation Measures HWQ1 (*Section 4.8 – Hydrology and Water Quality*) and GS1 will reduce the geology and soils impacts of the proposed project to a level of less than significant.

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